Assignment 3

Report

SYSC 4001

Operating Systems

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Part 1: https://github.com/NotReallyAPro/SYSC4001_A3_P1

Part 2: https://github.com/Julien-Bolduc/SYSC4001_A3P2

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1.0 INTRODUCTION

The purpose of this report is to outline the simulator and its simulation results. It will go over the implementation of the simulator and the seven input files used to obtain the results.

2.0 SIMULATOR

The simulator simulates the execution of three different schedulers. These schedulers are:

1. External Priorities (lower PID has higher priority)
2. Round-Robin (100 millisecond time slice)
3. a combination of the former two

Given an input file, the simulator populates the PCB and simulates the execution of these schedulers. The input file is a list of processes to run. The simulator outputs a file: execution.txt which holds the state information of every process anytime it changes states.

3.0 INPUT FILES

The seven input files used fall into one of three categories:

1. mostly I/O (80% of bursts is I/O)
2. mostly CPU (80% of bursts is CPU)
3. similar CPU and I/O (I/O and CPU bursts are equal)

For mostly I/O and mostly CPU input files, these can fall into one of three sub categories:

a: high I/O frequency (I/O occurs every ≤ 100 milliseconds; low I/O duration)
b: low I/O frequency (I/O occurs every > 100 milliseconds; high I/O duration)
c: mixed I/O frequency

While each input file has a different list of processes, all of them have a total CPU and I/O burst of 6000 milliseconds.

Four test input files were provided. The results of these files will not be analyzed in this report.

4.0 RESULTS

The results are analyzed through four metrics: throughput, average response time, average turnabout time, and average waiting time. Tables 1 to 4 below lists the metrics of each scheduler for each input file.

Table 1: Throughput of each scheduler in milliseconds

Schedulers / Input Files	External Priority	Round-Robin	External Priority and Round-Robin
1. Mostly I/O with high I/O freq.	1333	1356	1333
2. Mostly I/O with low I/O freq.	1914	2058	2000
3. Mostly I/O with mixed I/O freq.	2005	1977	1924
4. Mostly CPU with high I/O freq.	4916	4865	4916
5. Mostly CPU with low I/O freq.	4800	4800	4876
6. Mostly CPU with mixed I/O freq.	4940	4943	4851
7. Similar CPU and I/O	3492	3034	3492

Table 1 above lists the throughput of each scheduler for each input file. As the proportion of CPU burst increases, the throughput of each scheduler increases. This is expected as only one CPU burst can occur at a time, meaning the minimum throughput is equal to the total CPU burst as demonstrated with input file 5. It can also be seen that the throughput of each scheduler with input file 1 is much lower compared to those in the same category. A reason for this could be that as I/O frequency decreases, the I/O duration increases greatly since the processes are mainly I/O. This can cause an event where if the I/O duration is large enough, every process will be in the waiting queue. This can be seen in each execution2_*.txt file where after process 68 switches to waiting at 675 ms, the CPU idles for several hundred ms before running another process.

It should also be noted that at high I/O frequency, external priorities scheduling with and without round-robin are equivalent as the time slice of 100 ms is large compared to the I/O frequency. This will continue to be seen in the tables below.

Table 2: Average response time of each scheduler in milliseconds

Schedulers / Input Files	External Priority	Round-Robin	External Priority and Round-Robin
1. Mostly I/O with high I/O freq.	7.17	7.17	7.17
2. Mostly I/O with low I/O freq.	260.2	183.4	260.2
3. Mostly I/O with mixed I/O freq.	164.75	91	104
4. Mostly CPU with high I/O freq.	1154.2	77.2	1154.2
5. Mostly CPU with low I/O freq.	1249.83	222.67	1155.33
6. Mostly CPU with mixed I/O freq.	1632.33	660.17	1606.5
7. Similar CPU and I/O	130.75	78	130.75

Table 2 above lists the average response time of each scheduler for each test case. As expected, the round-robin scheduler has the lowest average response time of the three schedulers as it guarantees each process will get at most 100 ms of CPU time. This, however, does not apply to the round-robin scheduler with external priority despite also having the same guarantee. This is because of the external priority where processes with a lower PID have a higher priority. This can be seen in execution5_*.txt where in round-robin, process 50 executes for the first time at 200 ms. In round-robin with external priority, process 50 executes for the first time at 606 ms after process 21 ran 6 consecutive times. This, however, is better compared to external priority alone where process 50 executes for the first time at 661 ms because there was no mechanism to interrupt process 75 at 100 ms.

Table 3: Average turnaround time of each scheduler in milliseconds

Schedulers / Input Files	External Priority	Round-Robin	External Priority and Round-Robin
1. Mostly I/O with high I/O freq.	1158.17	1158.67	1158.17
2. Mostly I/O with low I/O freq.	1481.4	1682.4	1504.6
3. Mostly I/O with mixed I/O freq.	1803.5	1776.25	1763
4. Mostly CPU with high I/O freq.	3314.6	4336.8	3314.6
5. Mostly CPU with low I/O freq.	3136.83	4420.33	2991.17
6. Mostly CPU with mixed I/O freq.	3098.67	4066.17	3152.17
7. Similar CPU and I/O	2409.25	2768	2409.25

Table 3 above lists the average turnaround time of each scheduler for each test case. As expected, round-robin scheduling has generally the worst average turnabout time of the three schedulers as it forces all processes, including the short ones, to wait for their turn. Similar to Table 1, the average turnaround time is positively correlated with CPU burst. The reason for this is the same: only one CPU burst can occur at a time, meaning the minimum turnaround time of a process is equal to its CPU burst time. While the average turnaround time of each scheduler with input file 1 is much lower than those in the same category, this can be attributed to the process count where input file 1 had 6 processes, input file 2 had 5 processes, and input file 3 had 4 processes.

Table 4: Average waiting time of each scheduler in milliseconds

Schedulers / Input Files	External Priority	Round-Robin	External Priority and Round-Robin
1. Mostly I/O with high I/O freq.	158.17	158.67	158.17
2. Mostly I/O with low I/O freq.	281.4	482.4	304.6
3. Mostly I/O with mixed I/O freq.	303.5	276.25	263
4. Mostly CPU with high I/O freq.	2114.6	3136.8	2114.6
5. Mostly CPU with low I/O freq.	2136.83	3420.33	1991.17
6. Mostly CPU with mixed I/O freq.	2098.67	3066.17	2152.17
7. Similar CPU and I/O	909.25	1268	909.25

Table 4 above lists the average waiting time of each scheduler for each test case. As expected, round-robin scheduling has generally the worst average waiting time as explained under Table 3 and the difference in average waiting time between schedulers is the same as the difference in average turnaround time between schedulers in Table 3. Similar to Table 1, the average waiting time is positively correlated with CPU burst. The reason for this is the same: only one CPU burst can occur at a time, meaning each process in the ready queue must wait for the extra CPU burst time.